

REMARKS

This is a simultaneous amendment with request for continued examination (RCE) filed under 37 C.F.R. 1.114 in response to the final Office Action mailed July 20, 2010.

I. CLAIM CHANGES

The order of the claims has been preserved, while adding limiting wording to distinguish between the prior art and the claimed invention, so that it is easier to establish that no new matter has been added to the claims to obtain the above-listed amended claims.

The term "only" no longer appears in the amended claims, because the applicants recognize that the word "only" in the chosen wording for the claims resulted in uncertainty regarding the scope of the applicants' claims and hence indefiniteness.

The method of treating the surface of the refractory material claimed in independent claim 17 has been limited to a method consisting of the recited steps, namely treating the surface with radiation from a CO₂ laser and

subsequently *optionally* tempering. Page 3, line 26, of the applicants' originally filed specification provides basis for the tempering step and use of the term "optionally" (the basis for "optionally" is the wording "can be" in line 26). This disclosure also indicates that it is known in the art to temper refractory material.

Thus the surface treatment method of claim 17 has been limited to a method of treating the surface with the laser radiation from a single laser, which is a CO₂ laser, without or without a tempering step.

Applicants are entitled to narrow the scope of their claims to a disclosed species of a generically claimed or disclosed invention (see M.P.E.P. 2163.05). Treating the surface with a CO₂ laser is disclosed in applicants' specification (e.g. see page 3 of the originally filed specification, especially lines 9 to 12).

Amended claim 17, which now uses "consisting of" as the transitional phrase to define the surface treatment method, does exclude any optional additional steps like the spraying of the surface with a powder or a solution before or during treatment with the laser radiation.

However dependent claim 8, which contained the subject matter regarding spraying of the surface with a powder or a solution, has now been amended by including the subject matter of the amended claim 17, so that it is an independent claim. Like the "tempering" step the step of spraying is an optional step that is

part of an alternative embodiment of the invention. Like claim 17 claim 8 has been amended to define the claimed method with "consisting of" wording. Thus the method of the amended independent claim 8 is in fact limited to the three recited steps, although steps b and c are both optional steps.

Claim 8 has also been amended to eliminate confusing wording regarding the nature of the treatment solution of step b. This change in claim 8 is supported by the disclosures in lines 20 to 22 of page 3 of applicants' specification.

Claim 22 for the method of making and/or processing a glass melt has been limited to using a refractory material that is treated according to the more limited method of amended claim 17, i.e. to a method in which the surface is treated with laser radiation from a CO₂ laser and with no other heating apparatus during the surface treatment and is subsequently optionally tempered prior to contact with the glass melt.

For completeness new independent method claim 23 has been added, which is limited to a method of making and/or processing a glass melt with a refractory material that is treated by the method according to the amended claim 8.

II. REJECTIONS UNDER 35 U.S.C. 112

Claims 2 to 8, 17 to 19, and 21 to 22 were rejected under 35 U.S.C. 112, second paragraph, for indefiniteness.

Claims 2 to 8, 17 to 19, and 21 to 22 were rejected under 35 U.S.C. 112, first paragraph, for failing to comply with the written description requirement.

The aforesaid claims were rejected for indefiniteness because of the manner in which the term "only" was included in the independent claims, which led to uncertainty regarding what steps or elements were excluded from the claimed methods. However the term "only" has now been deleted from independent claims 17, 8, and 22 and the transitional wording in these claims has been changed from "comprising" to "consisting of". Since "consisting of" excludes any steps following its recitation except for those recited in the respective claim (M.P.E.P. 2111.03), the scope of the coverage provided by the independent claims is now definite.

Similarly the independent claims 17, 8, 22 and 23 now comply with the written description requirement because they are fully supported by the original disclosures as of the filing date, but are limited to preferred or alternative embodiments of the method, as explained in section I above.

For the aforesaid reasons withdrawal of the rejection of amended claims 2 to 8, 17 to 19, and 21 to 22 under 35 U.S.C. 112, second paragraph, for indefiniteness is respectfully requested.

Furthermore withdrawal of the rejection of amended claims 2 to 8, 17 to 19, and 21 to 22 under 35 U.S.C. 112, first paragraph, for failure to comply with the written description requirement is respectfully requested.

In addition, it is respectfully submitted that new claim 23 complies with the provisions of 35 U.S.C. 112, first and second paragraph, for the same reasons.

III. THE OBVIOUSNESS REJECTION OF INDEPENDENT CLAIM 17

Claims 3 to 7, 17 to 19, and 21 were rejected as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, (called "Recasens" herein below), in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited) and further in view of US 3,360,353, Torok, et al, (previously cited), and further in view of Brennan, et al (previously cited).

A. The Applicants' Invention

As it is now claimed in the independent claim 17 applicants' invention is an

effective method for treatment of a refractory surface

- (a) with laser radiation of single CO₂ laser that
- (b) produces a closed vitreous surface layer without pores or cracking

that reduce mechanical strength (applicants' specification, p. 2, line 23 and page 4, line 3).

Amended claim 17 with limiting "consisting of" wording now excludes simultaneous treatment or pre-heating with an oxyacetylene torch as in the case of Bradley, et al, and includes the step of treating the surface of the refractory material with radiation from a CO₂ laser so as to form a closed vitreous layer.

Simultaneous treatment with the oxyacetylene torch is particularly disadvantageous because the stream of fast-flowing combustion gases causes surface contamination and deformation because of the momentum of the combustion gases incident on the melt surface (see page 3, lines 2 to 3, and lines 12 to 14, of applicants' specification).

Amended claim 17 also excludes simultaneous treatment or pre-heating with radiation from a dye laser as in Triantafyllidis, et al.

B. The Differences between the Prior Art Methods and that of Claim 17

Recasens (newly cited) describes refractory bricks specifically for use in glass furnaces, which have a composition that falls within that of the amended claim

17. The composition of the refractory product claimed by Recasens in their claim 1 and abstract is: 1 to 74 wt. %, Cr₂O₃; 15 – 40 wt. %, ZrO₂; 3 – 76 wt. %, Al₂O₃; and 7.5 to 20 wt. %, SiO₂. The brick can also include minor amounts of MgO or other alkaline earth metal oxides.

Recasens does disclose that zirconia is included to improve the plasticity of the bricks, which reduces cracking in column 3, lines 19 to 30, which is relevant to the present invention, because cracking after their treatment process is a particular problem according to Bradley, et al, and other references.

Recasens shows that by including chromia in prior art compositions for the refractory product in comparatively large amounts, the resistance of the refractory product to corrosion by contact with molten glass can be increased (example 1 and table in columns 5 and 6). Although zirconia is also helpful it seems to be of secondary importance in promoting the resistance of the refractory product (table in columns 5 and 6). Recasens uses standard prior art methods to cast the refractory product (see example 1).

Brennan does disclose increasing the strength of a vitreous glass ceramic body by thermal tempering, which is relevant to the second optional method step in applicants' more limited amended claim 17.

However Brennan is not relevant to the first step according to claim 17, namely treating the surface of the refractory product with radiation from a single CO₂. Thus Brennan cannot suggest any of the additional modifications of the combined disclosures of Triantafyllidis, et al, and Bradley, et al, which are necessary to arrive at the method claimed in the amended claim 17 under 35 U.S.C. 103 (a).

Torok does disclose a mandrel 24 comprising cylindrical segments of refractory material that surround a coaxially arranged Danner blow pipe 23 for use in a Danner process for making a glass tube in column 3, line 68 and following. Torok does disclose outgassing of the refractory segments and wear and shape changes in their outer surfaces that cause problems with the glass products during long term usage of the mandrel in the Danner process in column 1, line 82, to column 2, line 14.

Torok allegedly solves problems regarding the quality of the glass tube that are produced by the apparatus by including a number of annular electrodes 27a, b, c along the mandrel 24 (fig. 3, column 4, especially lines 4 to 10) in order to control the temperature in various zones of the mandrel 24 by joule heating of the molten glass (column 5, lines 30 to 50).

Thus Torok employs an alternative and different solution to the problems created by erosion of the mandrel 24 by contact with a glass melt in their Danner

process. Torok leads away from the applicants' method of solving the aforesaid problems.

Torok is not relevant to the first step according to claim 17, namely treating the surface of the refractory product with radiation from a single CO₂. Thus Torok also cannot suggest any of the additional modifications of the combined disclosures of Triantafyllidis, et al, and Bradley, et al, which are necessary to arrive at the method claimed in the amended claim 17 under 35 U.S.C. 103 (a).

The content of Bradley, et al, and Triantafyllidis, et al, have been generally described on pages 9 to 12 of the amendment filed May 5, 2010. That description of those prior art references is not repeated here, but is incorporated by reference thereto in these REMARKS.

Page 7 of the final Office Action admits that Bradley, et al, teaches pre-heating is necessary in connection with their laser treatment with the CO₂ laser to reduce surface porosity and that without the pre-heating with an oxyacetylene torch cracks form in the surface of the refractory material that is treated with the laser radiation. From the standpoint of glass quality and damage to the refractory material coming in contact with the refractory surface it seems that it would not make too much difference whether the surface irregularities are caused by cracking or corrosion with the melt – they would still have a damaging effect.

As admitted on page 7 of the Office Action claim 17 excludes the pre-heating of Bradley, et al, with the oxyacetylene torch. The applicants' claims cover a treatment with a single CO₂ laser that surprisingly without pre-heating provides a refractory material with a closed vitreous surface. Applicants' dependent claims cover preferred embodiments with preferred laser beam power levels and scan rates that facilitate good results and production of the closed vitreous surface layer.

However the final Office Action cites Triantafyllidis, et al, for teaching a method of treating the surface of the refractory material solely with laser radiation including a pre-heating and post-heating the refractory surface with dye laser radiation and heating the refractory surface with CO₂ laser radiation (page 142, right hand column, and page 143, left hand column), which produced a smooth crack-free surface (conclusion page 144, fig. 4).

The applicants' teach that the resulting surface layer on the refractory material is "a closed vitreous layer" (specification page 4, line 3) due to treating the surface with the radiation of a single CO₂ laser. Furthermore the REM photograph of a cross-section through glass in contact with the treated refractory material (applicants' fig. 1b and the description in the example in their specification) shows that the vitreous surface layer 1b is smooth without any cracks and thus crack-free.

C. The Reasons for the Obviousness Rejection

The applicants' results (e.g. see applicants' fig. 1b) show that surprisingly in view of the disclosures of Bradley, et al, and Triantafyllidis, et al, the claimed method according to claim 17 produces a smooth crack-free or closed vitreous surface layer on the refractory material by treatment with laser radiation from a single CO₂ laser without pre-heating with an oxyacetylene torch (Bradley, et al) and without pre-heating and post-heating with a dye laser (Triantafyllidis, et al).

The combination of the disclosures of Bradley, et al, and Triantafyllidis, et al, with those of Recasens and Torok leads to a method of treating the refractory surface with laser radiation, which includes a pre-heating step that employs expensive additional equipment, such as a dye laser or an oxyacetylene torch, and requires considerable additional work. Both primary references teach that the pre-heating or the pre-heating and post-heating is essential to produce a closed (i.e. crack-free) vitreous surface. The combined prior art contains no teaching or suggestion that the pre-heating can be dispensed with or eliminated.

Furthermore the Office Action agrees that the pre-heating of Bradley, et al, is excluded according to page 4 of the final Office, but correctly noted that the previous claim 17 without the new limitations that are added by this amendment did not exclude pre-heating with laser radiation. However claim 17 has now been amended with "consisting of" wording to exclude the pre-heating with the laser

radiation from another different laser (page 7 of the Office Action in the reasons for rejecting claim 22).

The applicants' method is thus simpler, less expensive and involves less work than the methods of the prior art, while at the same time achieves the desirable closed vitreous surface which is crack-free surface. The considerable effort and expense in the development work to find the best treatment method for treating the refractory surface to overcome the problems described in Triantafyllidis, et al, and Bradley, et al, clearly indicates that the discovery of the particularly simple and inexpensive method of the applicants' is not a matter of routine experimentation.

Thus the combined prior art does **not** result in the method claimed in claim 17 because it lacks the negative limitation regarding "pre-heating" with an oxyacetylene torch or with another different laser or any suggestion of that negative limitation. The prior art must teach or suggest each and every limitation of a claimed invention (M.P.E.P. 2143.03).

In addition Torok teaches a different solution involving passing an electric current through the glass melt that comes into contact with the refractory surface. Thus Torok **leads away from the claimed invention**, because those utilizing the solution of Torok would not treat the surface of the refractory material in the mandrel with laser radiation prior to use in a Danner process. A prior art

reference that teaches away from a claimed invention should not be combined with other references to reject the claimed invention under 35 U.S.C. 103 (a).

See M.P.E.P. 2145 X.

On the elements or meaning of “teaching away” the Federal Circuit has said (as quoted in *In re Kubin*, 561 F.3d 1351 (Fed. Cir. 2009)):

"A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *In re Gurlev*, 27 F.3d 551, 553 (Fed. Cir. 1994).

The use of the electrodes in the mandrel 24 of Torok would lead those skilled in the art in a “divergent direction”, which thus constitutes teaching away from the claimed invention according to claim 24. M.P.E.P. 2141.02 VI actually states that the prior art must be considered as a whole and that portions that would lead away or teach away from the claimed invention must be fairly considered.

The last paragraph of section VI of M.P.E.P. 2141.02 VI is as quoted on page 13 of the Office Action, but the solution of Torok would “discourage the solution claimed” for the Danner process and the mandrel used in the Danner process, because the use of the mandrel of Torok with the electrodes built into it would eliminate expensive and costly treatment of the refractory surface involving use of lasers and improve the quality of the glass tubing.

Furthermore the quotation that was taken from *In re Kubin* above is more recent than the quotation in M.P.E.P. 2141.02 VI in the Office Action. According to the above-cited quotation from *In re Kubin* a reference that leads one skilled in the art in a "divergent direction" (i.e. an alternative solution) is a reference that "teaches away" from a claimed invention.

In addition, the solution of Torok is not merely a preferred or alternative embodiment of Torok but is the main feature of their solution and is the only solution disclosed in the combined prior art that is used for the refractory mandrel in the Danner process.

It is respectfully submitted that the experimentation mentioned on page 10 of the Office Action that was required to arrive at the applicants' claimed method according to claim 17 is not routine. The amount of effort involved was great, because the different parameters to be selected and adjusted in the surface treatment with the CO₂ laser, such as continuous versus pulsed laser, laser power, laser beam power density at the surface, wavelength of the laser radiation, scan rate, etc as well as other conditions such as temperature, are considerable in number. Furthermore page 204, right hand column, of Bradley, et al, mentions a number of different attempts to find new ways to laser treat the surface of the refractory material to strengthen it against corrosion. The number of papers regarding surface treatment of the refractory material with laser radiation is clearly evidence that the experimentation to find a simple treatment in

which a single laser can be used without pre-heating and which results in a closed vitreous surface layer without cracking according to the amended claim 17 was not merely routine.

The modifications of the subject matter of the combined prior art are neither disclosed nor suggested in the above-cited combined prior art references.

Accordingly claim 17 avoids a finding of obviousness under the classic TSM test for obviousness, because there is no hint or suggestion in any of the above-cited prior art references to dispense with the pre-heating steps of Bradley, et al, and Triantafyllidis, et al, which are excluded from claim 17.

Furthermore predictability is lacking with respect to the newer rationale for obviousness according to M.P.E.P. 2143 and the more recent KSR decision. One skilled in the art could not predict that it would be possible to find suitable operating parameters for the CO₂ laser so that a continuous treatment of the refractory surface with the radiation from only the CO₂ laser without pre-heating with another laser beam or with an oxyacetylene torch would provide a closed vitreous surface without formation of cracks in the surface. The cited prior art references teach away from methods of treating the refractory surface that do not include a pre-heating step as well as a step of treating with the laser radiation of a single CO₂ laser.

One skilled in the art would not find that the method of amended claim 17 has a reasonable expectation of success from the combined prior art; it would be the opposite -- reasonable expectation of failure without pre-heating or simultaneous heating during treatment with the CO₂ laser radiation.

Since the method as recited in the amended independent claim 17 is part of the method claimed in independent claim 21, independent claim 21 is also not *prima facie* obvious from the above-stated combined prior art.

For the aforesaid reasons and because of the additional limitations in amended claim 17, withdrawal of the rejection of amended independent claim 17 and dependent claims 3 to 7, 18 to 19, and 21 as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, in view of Bradley, et al, in view of Triantafyllidis, et al, and further in view of US 3,360,353, Torok, et al, and Brennan, et al, is respectfully requested.

IV. THE OBVIOUSNESS REJECTION OF AMENDED INDEPENDENT CLAIM 8

Claims 8 and 2 were rejected as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, (called "Recasens" herein below), in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited) and further in view of US 3,360,353, Torok, et al, (previously cited), in view of Brennan, et al

(previously cited), and further in view of US 4,814,575, Petitbon as evidenced by U.S. 3,929,498 Hancock, et al.

Claim 8 has now been amended by including the features and limitations of claim 17 so that it is not obvious for the same reason -- pre-heating is excluded.

Hancock only discloses a sintered zirconium body of a particular composition and is only cited for teaching a melting point. Thus Hancock is not relevant for any of the features and limitations of the claimed laser treatment method of claims 17 and 8.

Petitbon does disclose treating the surface of a ceramic, i.e. refractory, material, which for example is used in heating engines and protective plating (column 1, lines 18 to 22), with laser radiation from a single CO₂ laser and simultaneously treating the surface with a ceramic powder that is melted together with the surface (column 2, lines 41 and following; claim 1). Thus Petitbon is clearly relevant to the method claimed in the amended claim 8.

However in column 3, lines 3 to 14, Petitbon teaches:

"It appears that in accordance with the invention microcracks are reduced by laser implantation (**their total elimination is not desirable, since the presence of a few microcracks is advantageous for increasing the toughness of the material**), i.e. by projecting a small amount of ceramic powder into the laser beam so that the powder arrives in the molten state on the surface to be treated

and at least partially compensates for the shrinkage related to the pores contained in the surface..."

Thus Petitbon teaches that their CO₂ laser should be operated and the method should be performed under conditions such that the microcracks in the refractory surface are not completely eliminated. Petitbon thus **teaches the opposite** from forming a **closed** vitreous layer on the refractory surface, which would not have cracks or micropores, as claimed in applicants' amended claim 17.

A prior art reference that **teaches the opposite** from the claimed invention should not be used alone or combined with other prior art references to reject the claimed invention under 35 U.S.C. 103 (a). See M.P.E.P. 2145 X. and also the Federal Circuit Court of Appeals has said:

"That the inventor achieved the claimed invention by doing what those skilled in the art suggested should not be done is a fact strongly probative of nonobviousness." in *Kloster Speedsteel AB v. Crucible Inc.*, 230 U.S.P.Q. 81 (Fed. Cir. 1986), on rehearing, 231 U.S.P.Q. 160 (Fed. Cir. 1986)

Also see the discussion regarding Torok and the claimed invention and M.P.E.P. 2141.02 in the above section regarding independent claim 17 regarding a prior art reference that teaches away from the claimed invention.

The difference in the methods of operating the CO₂ laser in Petitbon and the applicants' disclosure is that the parts of the ceramic material or refractory material that are strengthened according to the method of Petitbon do not come

in contact with a glass melt and thus does not experience erosion or corrosion due to the action of the glass melt. The refractory surface that comes in contact with the glass melt must be a closed surface without cracks or pores to prevent penetration by the glass melt, which facilitates corrosion.

For the aforesaid reasons and because of the changes in claim 8 withdrawal of the rejection of claims 8 and 2 as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited) and further in view of US 3,360,353, Torok, et al, (previously cited), in view of Brennan, et al (previously cited), and further in view of US 4,814,575, Petitbon as evidenced by U.S. 3,929,498 Hancock, et al, is respectfully requested.

V. THE OBVIOUSNESS REJECTION OF INDEPENDENT CLAIM 22

Claim 22 was rejected as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited).

Claim 22 has now been amended to limit the method of making and/or processing the glass melt to bringing the glass melt into contact with the surface of a refractory material that has been treated according to the method now claimed in the amended claim 17. Thus claim 22 claims a method that is limited

to a surface of a refractory material that has been treated by a method consisting of treating the refractory surface with laser radiation from a single CO₂ laser and subsequently tempering. Pre-heating steps for treatment of the surface are excluded from claim 22.

In fact method claim 22 includes all the features and limitations of claim 17 and thus a case of *prima facie* obviousness of claim 22 based on the combined prior art is **not** established for the reasons set forth in section III above.

For the aforesaid reasons and because of the new limitations in claim 22, which are the same new limitations that were added to claim 17, withdrawal of the rejection of claim 22 as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited) with or without Torok and/or Brennan, is respectfully requested.

Similarly it is also respectfully submitted that new method claim 23, which contains the additional limitations of claim 8 as well as claim 17, should **not** be rejected as obvious under 35 U.S.C. 103 (a) over US 3,837,870, Recasens, et al, in view of Bradley, et al (previously cited), in view of Triantafyllidis, et al (previously cited) with or without Torok and/or Brennan.

Should the Examiner require or consider it advisable that the specification, claims and/or drawing be further amended or corrected in formal respects to put this case in condition for final allowance, then it is requested that such amendments or corrections be carried out by Examiner's Amendment and the case passed to issue. Alternatively, should the Examiner feel that a personal discussion might be helpful in advancing the case to allowance, he or she is invited to telephone the undersigned at 1-631-549-4700.

In view of the foregoing, favorable allowance is respectfully solicited.

Respectfully submitted,



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